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(54) Title of the Invention Automatic Wafer Grinding Device

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(72) Inventor: Toshiyuki Mori
Disco Corporation
2-14-3 Higashi Kabatani, Ota-ku, Tokyo

(71) Applicant: Disco Corporation
2-14-3 Higashi Kabatani, Ota-ku, Tokyo

Specifications

1. Title of the invention Automatic wafer grinding device

2. Claims

(1) An automatic wafer grinding device comprised of a wafer loading unit equipped with a transfer belt for transport that sequentially removes wafers from a wafer cassette;
a grinding unit equipped with a turntable furnished with a plurality of chuck tables that loads wafers transferred from the wafer loading unit, a spindle equipped with a grinding stone to grind the wafers on the chuck tables and a means to remove particles and grinding water;
a washing unit equipped with a spinner table that washes and dries the wafers on the spinner table by rotating the spinner table;
and a wafer unloading unit equipped with a transfer belt that sequentially loads wafers on the transfer belt into a wafer cassette after washing.
(2) An automatic wafer grinding device as claimed in Claim 1 where the transfer means for transport of wafers between units is unitized.
(3) An automatic wafer grinding device as claimed in Claim 1 and Claim 2 where there are two chuck tables installed on the turntable.

(4) An automatic wafer grinding device as claimed in Claim 1 and Claim 3 where the grinding unit is equipped with a thickness detector to detect the thickness of the wafer on the chuck table.
(5) An automatic wafer grinding device as claimed in any of Claims 1-4 where the washing unit is equipped with a measuring table, a roughness detector that detects the surface roughness of the wafer on the measuring table and a swing arm that transfers the wafer from the spinner table to the measuring table as well as transfers the wafer from the measuring table to the wafer unloading unit transfer belt.

3. Detailed Description of this Invention

[Industrial Field of Application]

This invention relates to a cassette-to-cassette style automatic wafer grinding device that automates the processes from sequentially removing wafers loaded in cassettes, grinding them to the proper thickness and loading the ground wafers into separate cassettes.

[Existing Art]

A cassette-to-cassette style automatic wafer grinding device is equipped with a rotary table that rotates in a specific direction and has many, 12 for example, chuck tables that are positioned on a turntable. Stations such as loading, grinding, unloading and removing particles are all equipped on the turntable. Each chuck table rotates in conjunction with the turntable, sequentially moving to each station to perform wafer unloading, grinding, unloading and particle removal processes. Typically, the grinding process is separated in the three processes of rough finishing, intermediate finishing and precision finishing. The spindles for the three grinding stones are arranged along the rotating tracks of the chuck tables on the turntable that can be raised and lowered. The grinding stones for the various levels of finishing, specifically rough finishing, intermediate finishing and precision finishing, are installed on the spindle.

Wafers are ground to a specific thickness with the automatic wafer grinding device while the turntable is rotating. The ground wafers are transported to the spinner table adjacent to the turntable where they are washed, dried and then loaded into a wafer cassette to complete the wafer grinding process.

The wafer grinding process using the automatic wafer grinding device involves transporting the wafer removed from the wafer cassette to the position adjacent to the turntable using the transfer belt. Next, the wafer is moved to the chuck table at the loading station from the transfer belt using the transfer arm for loading. Then the chuck tables loaded with the wafers rotate in conjunction with the turntable to the grinding station. At the grinding station, the chuck tables are rotated and rotation of each spindle performs sequential grinding of the wafers on the chuck table using the grinding stones for rough finishing, intermediate finishing and precision finishing. The ground wafers are unloaded from the chuck table using the transfer arm, placed on the spinner table and washed/dried with the spinner table. Then, they are unloaded from the spinner table using the transfer arm, placed on the transfer belt for transport and sequentially loaded into wafer cassettes.

With existing automatic wafer grinding devices such as that described above, the grinding stones for rough finishing, intermediate finishing and precision finishing sequentially complete the proper amount of grinding. All of the wafer grinding processes are automated so manual labor is not necessary to efficiently obtain wafers of a specific thickness.

[Problems this Invention is to Solve]

With existing automatic wafer grinding devices such as that described above, typically the three spindles are positioned on the turntable for raising and lowering such that it is possible to conduct rough finishing, intermediate finishing and precision finishing. However, there are many types of grinding processes required by users, including grinding processes that cannot be classified as rough finishing, intermediate finishing and precision finishing, and those that can be completed with a single grinding operation. In this case, there is no need for the other two grinding processes and a single spindle is sufficient. Currently, three spindles are standard on automatic wafer grinding devices and there are no products with only a single spindle on the market. As a result, in spite of only using one spindle, users

are forced to purchase the standard type automatic wafer grinding devices complete with three spindles. This standard type automatic wafer grinding device is not financially feasible,

requires large amounts of space and is not appropriate for the users.

Also, when the grinding rate is high, rough grinding is divided into two parts so grinding is performed a total of 4 times. In this case, the turntable is rotated twice and in addition to performing the necessary grinding processes, labor is necessary to replace the grinding stones which diminishes the merits of automation.

This standard type automatic wafer grinding device does not satisfy the needs of a wide variety of users and lacks broad applications.

[Objective of this Invention]

The objective of this invention is to present an automatic wafer grinding device that has wide applications to satisfy the requirements of a broad range of users.

[Summary of this Invention]

To achieve this objective, this invention is for an automatic wafer grinding device that unitizes specialty equipment to perform each process. The grinding unit only has one spindle. The optimal automatic wafer grinding device includes grinding units as needed that correspond to the type of grinding required by the user. When conducting grinding according to rough finishing, intermediate finishing and precision finishing, the automatic wafer grinding device includes three grinding units. However, when single grinding is sufficient, one grinding unit is employed and when rough finishing is required, the automatic wafer grinding device provides four grinding units.

[Embodiment Examples]

A detailed description of the embodiment examples for this invention is provided next, using the diagram as a reference.

The automatic wafer grinding device 10 relating to this invention unitizes specialty equipment to perform each process for grinding wafers.

In this embodiment example, from right to left, the automatic wafer grinding device 10 is constructed of a wafer loading unit 12, grinding units 14, 15, a washing unit 16, a wafer unloading unit 18. Additionally, in the front (bottom of the figure) is a transfer unit 20. An automatic wafer grinding device 10 with this type of construction loads the wafers from the right and transports them to the left through grinding, washing, drying and unloading. The grinding water supply unit 19 holds the reservoir for the grinding water and washing liquid as well as a pump and is positioned independently behind the wafer loading unit 12. The vacuum unit 21 supplies negative pressure to the vacuum tray that uses negative pressure and is positioned independently behind the wafer unloading unit 18. The water supply unit 19 and vacuum unit 21 are connected to the other units. These units 19, 21 are unitized and do not need to be independent so can be included in the wafer loading and other units as necessary. If these units 19, 21 are unitized, units 12, 14, 16 and 18 are mechanically simplified and can be made compact.

The wafer loading unit 12 can be separate from wafer loading so it can be possible to process two connected wafer cassettes 22, 23. The wafer loading unit 12 is installed to the right of the elevator table and the wafer cassettes 22, 23 are positioned on the elevator table. Typically, 25 wafers 26 with their circuit patterns positioned face up are separated at a specific pitch P in a perpendicular direction and loaded to the wafer cassettes 22, 23. The elevator table can be lowered at pitch P. Transfer belts 28, 29 extend to the left of the elevator table and the transfer arm 32 and reverse arm 33 are located on the left of the transfer belts 28, 29. The transfer arm 32 and reverse arm 33 are located

on one side of the vacuum trays 34, 35 that use negative pressure to secure the wafers 26 while the other side is supported by sliding guide rails 36, 37. The transfer arm 32 is positioned on the transfer belt 28 and the vacuum of the vacuum tray 34 is on the bottom. The reverse arm 33 is positioned to be raised and lowered via the transfer belt, with the vacuum from the vacuum tray on the top. The guide rails 36 are installed on the transfer means formed as a part of the transfer unit 20. The keyboard 40 with various switches is installed on the right side of the transfer means 38. The driver, controller and control box for the wafer loading unit 12 are located in the wafer loading unit under the transfer belts 28, 29.

The wafer loading unit 12 with the aforementioned structure sequentially removes the wafers 26 inside the wafer cassette 22 from the front. The transfer belt 28 is constructed of two endless wires. The elevator table is lowered at pitch P (the same as the space where the wafers are loaded into the wafer cassette) and the wafers 26 are sequentially loaded to the transfer belt 28 from the bottom of the wafer cassette 22 and transferred to the left. By transporting wafers 26 to the left, the transfer belt 28 stops. In the same way as inside the wafer cassettes 22, the wafer 26 circuit pattern is placed that side up. Grinding is performed on the reverse side of the circuit pattern so the top/bottom surfaces of the wafer 26 are reversed. Reversing the wafers 26 is performed by the reverse arm 33. The reverse arm 33 is positioned below the transfer belt 28 and when the wafer 26 is transported, the reverse arm 33 is elevated and the wafer secured by the vacuum tray 35. Next, the reverse arm 33 raises the secured wafer 26 and rotates 180° with the transfer belt 28. The wafer is reversed and the circuit pattern surface is face down. The reverse arm 33 is lowered and the wafer 26 is moved on the transfer belt 28. Then, the transfer arm 32 is lowered and the wafer 26 is secured via the vacuum of the vacuum tray 34. After the transfer arm 32 is lifted, it is guided along the guide rails 38 and sequentially transports the wafer 26 to the next grinding unit. While the transfer arm 32 is transporting the wafer 26, the reverse arm 33 is lowered and reversed to under the transfer belt and so is face up to the vacuum tray 35. When the wafer cassette 22 is empty, wafers 26 are removed from the next wafer cassette 23 using the transfer belt 29 in the same manner, and then transported to the left. By transporting wafers 26 to the left, the transfer belt 28 stops and the wafers are secured by the reverse arm 33. After securing the wafers 26, the reverse arm 33 is lifted, reversed and the wafer is reversed. Then the reverse arm 33 is moved to the front along the guide rails 37 and the wafer 26 is moved to the left of the transfer belt 28. Next, the wafer 26 is secured to the transfer arm 32 and transported to the next grinding unit 14. The wafers 26 in the wafer cassette 23 are sequentially removed and while in transit, the empty wafer cassette 22 is replaced.

In this manner, wafers 26 are removed from the wafer cassettes 22, 23 and transported so the replacement of the wafer cassettes 22, 23 can be automatically performed using the program installed in the wafer loading unit 12 control box.

In the embodiment examples, the grinding process is divided in two so two grinding units 14, 15 are installed to the left of the wafer loading unit 12. In the embodiment examples, the automatic wafer grinding device 10 has a two-axle construction. The structure of the grinding unit 14 is described below but the grinding units 14, 15 do not have to be structurally identical.

The grinding unit 14 contains a turntable 44 and multiple, say 2, chuck tables 46,

47 installed on the turntable. The driver, controller and control box for the grinding unit 14 are located behind the turntable 44. There is a brace 52 on the spindle 50 that can be raised and lowered. The grinding stones 53 are attached to this spindle 50. A pair of particle removal means such as brushes 54, 55 are installed on the turntable 44 that can be raised and lowered. These brushes 54, 55 are lowered until they contact the chuck table and then are rotated so the particles and grinding water are removed from the top. The transfer means 56 that forms a portion of the transfer unit 20 is attached to the front of the grinding unit 14 and the transfer arm 58 is installed on the guide rail 60 of the transfer means 56 and is capable of sliding. The guide rail 60 is formed to connect to the guide rail 36 on the transfer means 38 to the right side. The vacuum tray 62 can be installed at the front edge of the transfer arm 58. The grinding unit 14 is equipped with a wafer thickness detection means 64. This wafer thickness detection means 64 contains two diamond probes 66 that can detect the Z-direction (depth) position of the wafer surface and the turntable surface loaded with the wafer, and can detect the wafer thickness with calculations using these detection values.

The wafer loading unit 12 transfer arm 32 slides to the left as guided by the guide rails 36 until it reaches the guide rail 60 of the grinding unit 14 with the above structure. The wafer 26 is loaded on the chuck table 46 at the loading station. The chuck table 46 loaded with the wafer 26 rotates in the counterclockwise direction with the turntable 44 so it moves toward the grinding station while rotating the chuck table 46. While the grinding water is added, the grinding stones 53 are rotated at high speeds and the wafer 26 on the chuck table 46 is ground. The grinding blade surface of the grinding stones 53 are positioned around the wafers 26 so the spindle 50 position is set. With this setting, there will be no indentations and a clean grinding surface will be obtained. The diamond probes 66 measure the position of the wafer surface and the chuck table surface and use these values to calculate the wafer 26 thickness. Then the cutting depth and the abrasion of the grinding stones 53 can be reviewed and adjusted. Then, by rotating the turntable 44 in the counterclockwise direction, the chuck table reaches the unloading station and the wafer 26 on the chuck table is transported to the next grinding unit with the transfer arm 58. Generally, the unloading station conforms to the loading station. The rotation direction of the turntable 44 is not uni-directional and can rotate either clockwise or counterclockwise. When the turntable 44 rotates in the counterclockwise direction, the brushes 54, 55 are lowered until they contact the chuck table 46, 47 wafer 26. They revolve as shown by the arrow and the particles and grinding water are removed from the top.

The same grinding process can be repeated on the grinding unit 15 and wafers 26 ground to the desired thickness from double grinding are moved to the next process via the transfer arm 58.

A washing unit 16 is installed to the left of the grinding units 14, 15. There is a transfer means 70 with guide rails 69 to the front of this washing unit 16. The guide rails 69 are connected to the guide rails 60 of the grinding units 14, 15. The washing unit 16 is constructed of a spinner table 72, a measuring table 74 and a three-position swing arm 76. The spinner table 72 can have a hood 78 made of clear plastic. The wafer 26 transported from the grinding unit 15 via the transfer arm 58 is placed on the spinner table 72. The hood 78 is placed in position to seal the wafer and the spinner table 72 is rotated while the washing water is supplied to wash the wafer 26.

Next, the spinner table is rotated at a high speed to remove any water droplets and dry the wafer. The dried wafer 26 is secured to the vacuum tray 77 of the swing arm 78 and the swing arm 76 revolves in the counterclockwise direction and the wafer 26 moves to the measuring table 74. There is a roughness detector 82 installed adjacent to the measuring table 74 that can be rotated. This roughness measuring apparatus 82 rotates in the counterclockwise direction and the surface roughness of the wafer 26 on the measuring table 74 is detected. After detecting the surface roughness, the wafer 26 is secured to the swing arm 76 and then transported to the left by rotating the swing arm in the counterclockwise direction.

The motions for each part of the washing unit 16 including the spinner table rotation, hood closing/opening, swing arm motion, vacuum operation, rotation of the roughness detection means 82 and detection operation, are conducted according to a specific program preset by the washing unit control box 83. The values detected by the roughness detection means 82 are recorded on the control box 83 and if the wafer surface roughness detected is outside the permissible range, there is a warning to replace the grinding stones 53 or the dressing. Wafers 26 with surface roughness outside the permissible range are recorded on the control box 83 and are separated from the wafers with surface roughness within the permissible range and processed accordingly. If they can be reground, they are. If not, they are discarded.

The wafer unloading unit 18 is adjacent to the washing unit 16 and is positioned to the left of the automatic wafer grinding device 10. If the wafer unloading unit 18 does not have a transfer arm 32, the construction will be identical to that of the wafer loading unit 12. The wafer unloading unit 18 is equipped with an elevator table that lifts and loads wafers at a given pitch P. The empty wafer cassettes 86, 87 are arranged on the elevator table. The transfer belts 88, 89 extend to the right from the elevator table and the reverse arm 92 is installed to the right of the transfer belts 88, 89. The guide rail 96 of the reverse arm 92 is installed to the right edge of the wafer unloading unit 18. The keyboard 87 with all of the switches is arranged to the front of the transfer belt 88.

When the swing arm 78 of the washing unit 16 rotates, the wafer 26 is transported from the measuring table 74 to the top of the transfer belt 89. The wafer 26 is reversed using the reverse arm 92 so the circuit pattern surface faces up and then it is once again placed on the transfer belt 89. The elevator table is elevated at a pitch of P and the movement of the transfer belt 89 to the left allows the wafer to be sequentially loaded from the top of the wafer cassette 87 with the circuit pattern surface face up. Once a specific number of wafers 26 are loaded into the wafer cassette 87, the subsequent wafer is loaded into the front wafer cassette 86. The transfer belt 89 stops and the wafer 26 transported using the swing arm 76 is temporarily stored at the right edge of the transfer belt 89. Then, the reverse arm 92 is operated and the wafer 26 is secured to the top of the transfer belt 89 via the vacuum tray 93. The reverse arm 92 reverses the secured wafer 26 and the wafer 26 circuit pattern is face up. The reverse arm 92 guides the secured wafer 26 along the guide rails 96 to the front and then transfers the wafer 26 to the right edge of the transfer belt 88. The transfer belt 88 shifts to the left and the wafer 26 is sequentially inserted into the elevated wafer cassette 86 at a specific pitch P. The wafer 26 is sequentially loaded from the top of the wafer cassette with the circuit pattern surface face up. While the wafer 26 is loaded into the wafer cassette 86, wafer cassette 87 can be replaced.

In the embodiment examples, the transfer unit 20 that transports the wafer 26 between each unit is comprised of a transfer means 38, 56, 70. However the transfer unit 20 is not limited to this configuration.

The transfer means for each unit can be independent from the transfer unit as in the embodiment example or the transfer means for each unit can be housed in each particular unit.

This invention only utilizes the minimum amount of space required so there is no wasted space.

The number of chuck tables installed on the turntable 44 is not limited to 2 but 2 is adequate for operating efficiency.

This invention has the objective of automating wafer grinding and the unitized structure enables the user to purchase only the grinding unit and then manually perform wafer loading and unloading. Later, the wafer loading unit, washing unit and unloading can be purchased to establish an entire automated system.

The embodiment examples given above are used to describe this invention but this invention is not limited to that given above. Modifications and improvements within the technical scope of this invention are also included as part of this invention.

[Effect of this Invention]

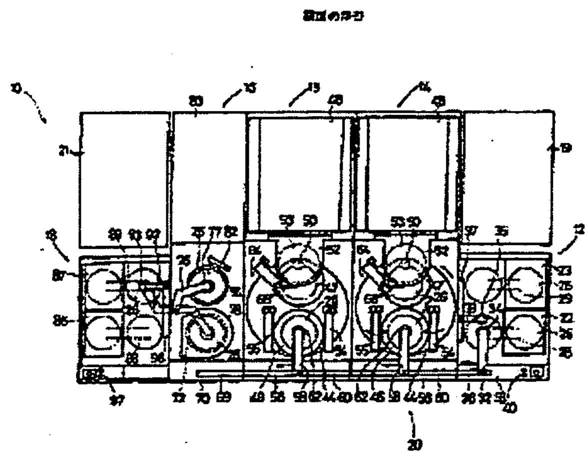
As indicated above, this invention is for an automatic wafer grinding device that unitizes specialty equipment to perform each process for wafer grinding. The grinding unit only has one spindle. The optimal automatic wafer grinding device includes grinding units as needed that correspond to the type of grinding required by the user. The automatic wafer grinding device meets the varying requirements of users. Selecting the number of grinding units enables a simple and inexpensive structure. The applications can be rapidly enhanced so efficient grinding is possible. Only the minimum amount of space is required so the space is effectively utilized.

Users can purchase only the grinding unit and then later, other units can be purchased. In this manner, an automatic wafer grinding system can be gradually established according to the budgets.

4. Brief Description of the Figures

The figure is an abbreviated front view of the two-axle automatic wafer grinding device relating to this application.

10: automatic wafer grinding device, 12: wafer loading unit, 14: grinding unit, 16: washing unit, 18: wafer unloading unit, 19: grinding water supply unit, 20: transfer unit, 21: vacuum unit, 22, 23, 86, 87: wafer cassette, 28, 29, 88, 89: transfer belt, 32, 33, 58: transfer arm, 36, 37, 60, 69, 98: guide rail, 38, 58, 70: transfer means, 44: turntable, 46, 47: chuck table, 50: spindle, 52: brace, 53: grinding stone, 54, 55: brush (means to remove particles), 64: thickness detector, 66: diamond probe, 72: spinner table, 74: measuring table, 76: swing arm, 80: roughness detector.



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   Disco Corporation
4. Agent
   Address: Flex Building, 3-35-3 Nakano, Nakano-ku, Tokyo 164
   Telephone: (03) 229-3145
   Name: Attorney (8613) Toshio Haka
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